



US Air Force

Building *Sustainability* into the Air Force Remediation Process

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SAM 2008 FALL FORUM

SAN DIEGO, CA

September 17, 2008



EARTH TECH

AECOM





Project Team

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Sustainability in AF Remediation: **Overview**

- **Problem & A Solution**
- **Solution Method**
- **Timeline**



Sustainability in AF Remediation: **Overview**

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Sustainability in AF Remediation: Problem & A Solution

Project Catalyst

3919

Federal Register

Vol. 72, No. 17

Friday, January 26, 2007

Presidential Documents

Title 3—

Executive Order 13423 of January 24, 2007

The President

~~Strengthening Federal Environmental, Energy, and Transportation Management~~

By the authority vested in me as President by the Constitution and the laws of the United States of America, and to strengthen the environmental, energy, and transportation management of Federal agencies, it is hereby ordered as follows:

Section 1. Policy. It is the policy of the United States that Federal agencies conduct their environmental, transportation, and energy-related activities under the law in support of their respective missions in an environmentally, economically and fiscally sound, integrated, continuously improving, efficient, and sustainable manner.



Sustainability in AF Remediation: Problem & A Solution

New Remediation Paradigm

- **Examples of Existing Metrics**
 - **CERCLA Nine Criteria**
 - **Risk and Economic Cost**
- **New Metrics**
 - **CO₂ Emissions**
 - **Energy Usage**
 - **Resource Service**

Goal: Add New Metrics to the Mix



Key Point: *New Metrics Represent Externalities Not Captured in Economic Cost or Other Metrics*

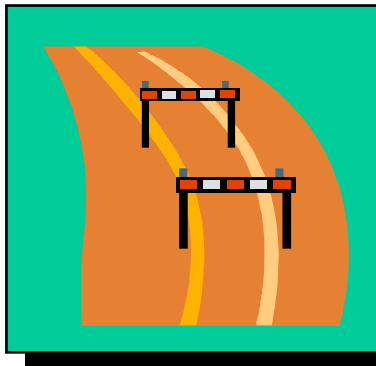


Sustainability in AF Remediation: Sustainability Paradigms

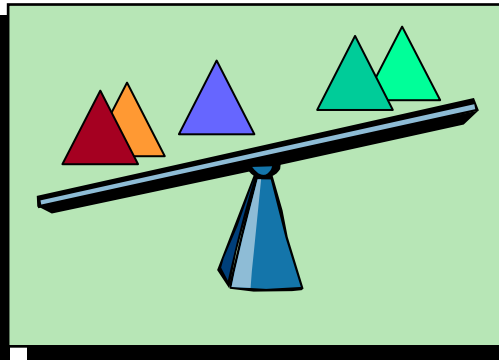
Example Existing Remediation Paradigm: CERCLA

**Nine Criteria for Remedial Investigation /
Feasibility Study and Selection of Remedy
40 CFR §300.430(e)(9)(iii)**

**Two
Threshold**



Five Balancing



**Two
Modifying**





Sustainability in AF Remediation: Problem & A Solution

The Problem...

Historical approach to contaminated sites does not fully consider sustainability concepts.

A Solution...

Develop tool to help AFCEE environmental professionals incorporate sustainability concepts into their remediation decision making process (e.g., PBEM, RRM, ERP-O) for

- i) planning future remediation implementation**
- ii) optimizing operating remediation sites**



Sustainability in AF Remediation: **Overview**

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- ➡ ***Solution Method***
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Sustainability in AF Remediation: **Solution Method**

What the Tool Does

Estimates sustainability metrics for specific technologies:

1. **Excavation**
2. **Soil Vapor Extraction**
3. **Pump and Treat**
4. **Enhanced Bioremediation**

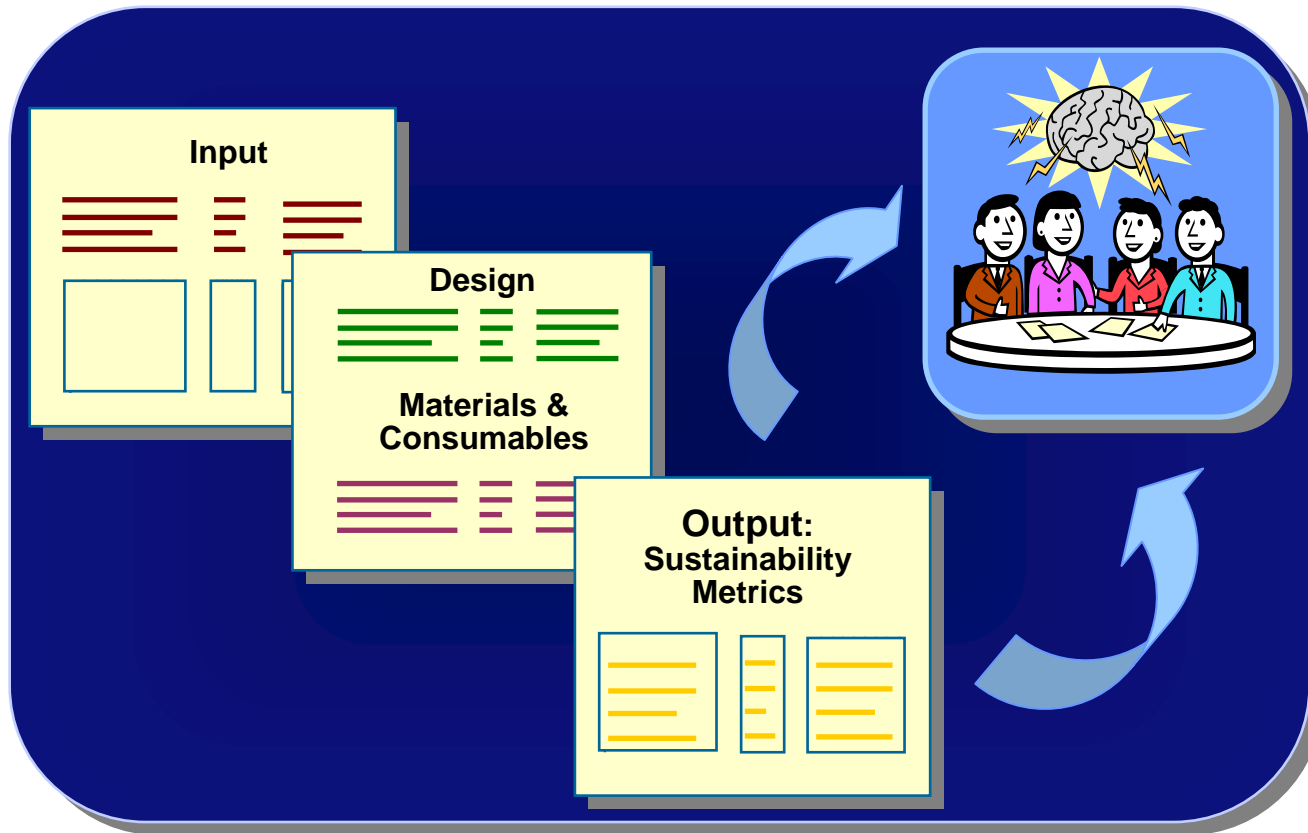
Sustainability metrics developed:

- **Carbon dioxide** emissions to atmosphere
- Total **energy** consumed
- **Change** in resource service
- Technology **cost**
- **Safety / Accident risk**

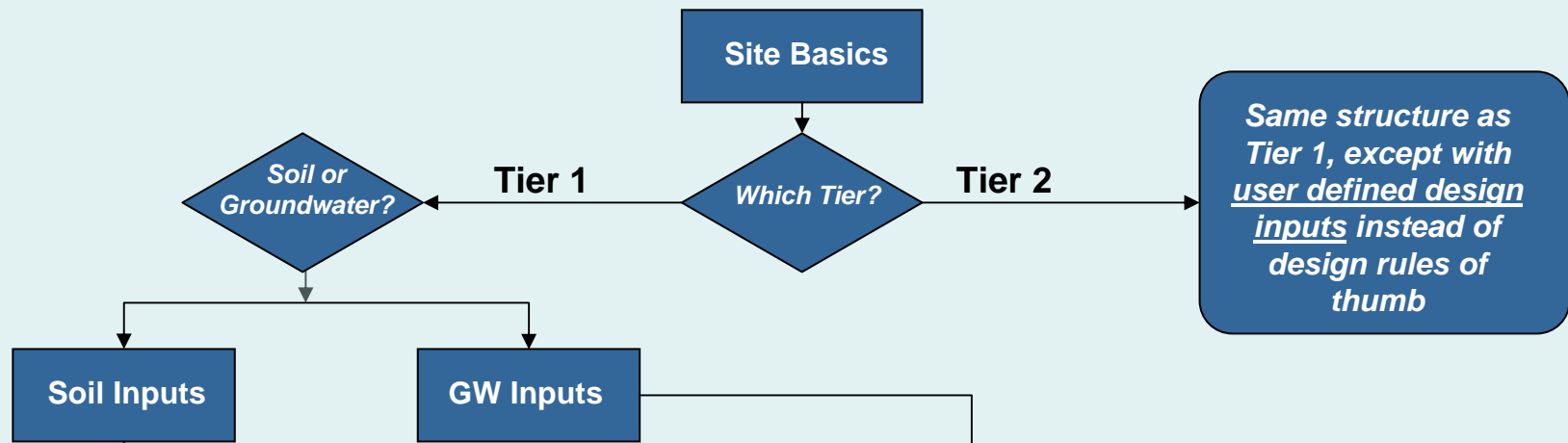


Sustainability in AF Remediation: **Solution Method**

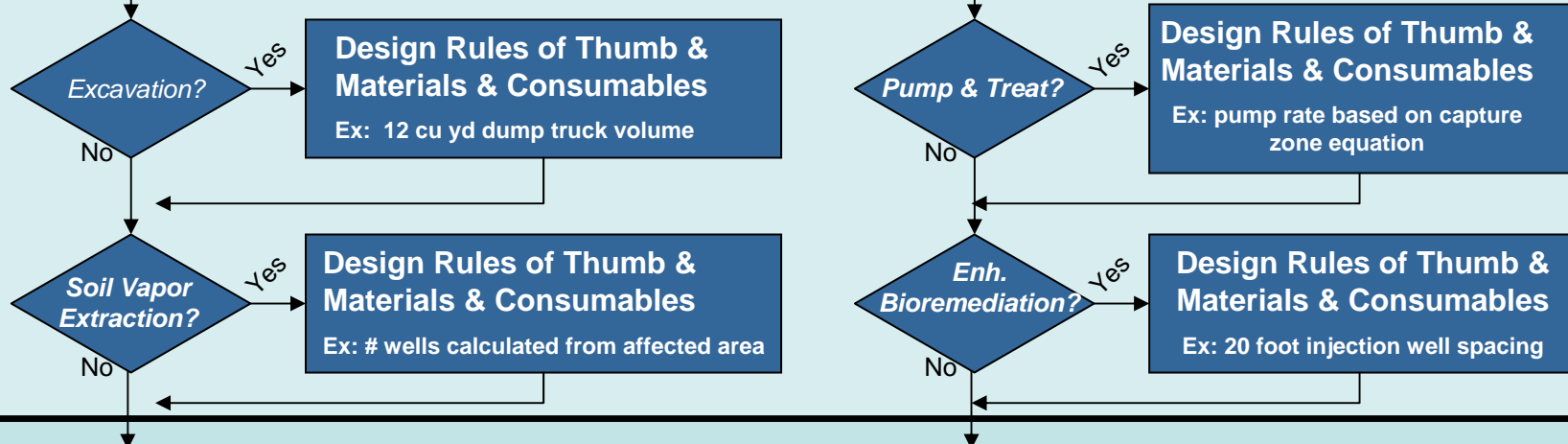
Tool Structure



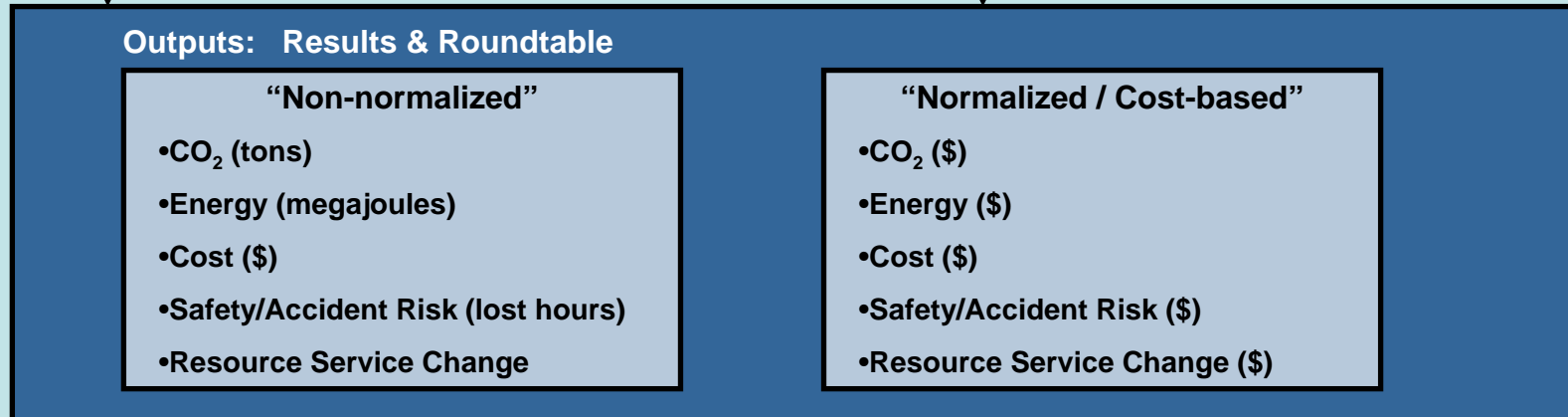
1



2



3





Sustainability in AF Remediation: **Solution Method**

Framework:

Tiers of Varying Detail

**Like RBCA
Toolkit!**

	Tier 1	Tier 2
Calculation Basis:	"Rules of Thumb"	User-entered design information from detailed design
Time Required:	1-2 hrs	1-2 days



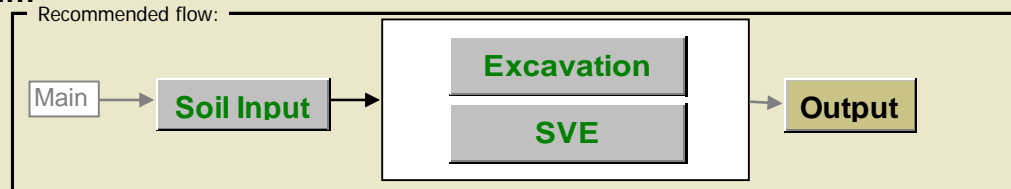
Sustainability in AF Remediation: Solution Method

Sustainability Tool Kit

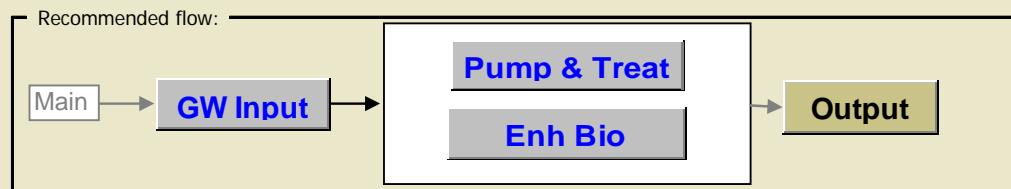
1. Enter Project Information

Site Name	EXAMPLE SITE
Location	ANYWHERE, ALASKA
New vs. Existing System	New
	<input checked="" type="checkbox"/> Tier 1 <input type="checkbox"/> Tier 2

2. Choose Soil...



or Groundwater...





Sustainability in AF Remediation: Solution Method

Soil/Source Input

EXAMPLE SITE
ANYWHERE, ALASKA

Area of Affected Soil 2500 ft²
Depth to Top of Affected Soil 0 ft
Depth to Bottom of Affected Soil 10 ft
Depth to Groundwater 15 ft

Soil Type Sand (well graded)

Contaminant Class CVOCs
Max Concentration (Key COC) 500 mg/kg
Typical Concentration for Total COCs 100 mg/kg

Contaminant mass of total COCs 250. lbs

Calculate natural resource service? ☒ Yes ☐ No

Land Value (in current state) \$10,000 \$/acre
Increase in economic value due to project Medium

Benefit to ecological service value due to project Medium
Current ecosystem setting Industrial
Future ecosystem setting Urban

Instructions:

=Enter your data here. Click button to the right of the cell for help.
 =Use this default value or override with your own.
 =Calculated value. You cannot change this.

Paste Tier 1 Example

Clear Soil Inputs

Recommended flow:

You are here

Main

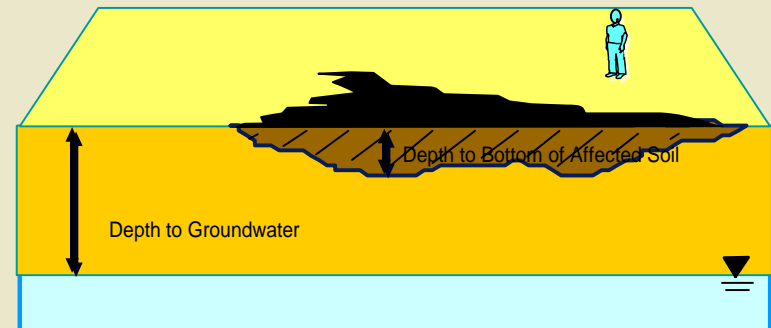
Input

Next: Choose Technologies

☒ Excavation
☐ Soil Vapor Extraction

Results

Next>>





Sustainability in AF Remediation: Solution Method

Excavation - Tier 1

EXAMPLE SITE
ANYWHERE, ALASKA

Tier 2: Change
Conv MOVE TO

Design for Managing Soil

Airline miles flown by project team (total miles for all travelers)	1000	miles over proj lifetime
Average Distance Traveled by Site Workers per one-way trip	10	miles
Trips by Site Workers during construction	2	# over project lifetime
Trips by Site Workers after construction	1	# over project lifetime

Distance to Disposal (one-way)	50	miles
Type of Disposal	Hazardous	

Volume of affected soil	25,000.	ft ³
-------------------------	---------	-----------------

Total hours to excavate	24.	person-hours
Number of loads for disposal	100.	#
Total miles driven for disposal	10,000.	miles

Total hours for fill dirt placement	9.3	hours
Number of loads of fill dirt	100.	#
Total miles driven for fill	2,000.	miles

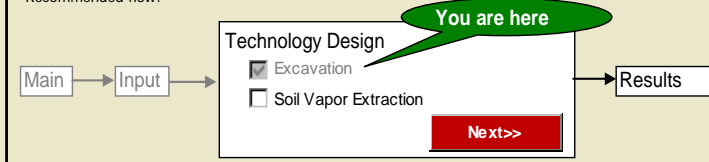
Tier 2: Detailed
Inputs to Change
Calculated Values

Instructions:

	=Enter your data here. Click button to the right of the cell for help.
	=Use this default value or override with your own.
	=Calculated value. You cannot change this.

Restore Defaults

Recommended flow:



Materials and Consumable Amounts used for Metrics

Diesel	1,600.	gal
Gasoline	7.9	gal

Project-specific Metrics (Addition & Subtraction/Carbon Offsets)

☒ Yes ☐ No



Sustainability in AF Remediation: ***Solution Method***

Example Material Calculation and Conversion

$$\begin{aligned} & \mathbf{2,500\ lb\ PVC} \times \frac{2\ lb\ CO_2}{1\ lb\ PVC} \times \frac{0.453\ kg}{1\ lb} \times \frac{0.001\ metric\ ton}{1\ kg} \\ & = \mathbf{2\ metric\ tons\ CO_2\ emitted} \end{aligned} \quad \text{“Non-normalized” natural units}$$

$$\begin{aligned} & \times \frac{\$5}{1\ ton\ CO_2} = \mathbf{\$10\ CO_2\ offset} \quad \text{“Normalized” \$ units} \end{aligned}$$



Sustainability in AF Remediation: ***Solution Method***

Example Consumable Calculation and Conversion

$$\begin{aligned} &100 \text{ gal gas} \times \frac{20.71 \text{ lb CO}_2}{1 \text{ gal gas}} \times \frac{0.453 \text{ kg}}{1 \text{ lb}} \times \frac{0.001 \text{ metric ton}}{1 \text{ kg}} \\ &= 1 \text{ metric ton CO}_2 \text{ emitted} \end{aligned}$$

“Non-normalized” natural units

$$\times \frac{\$5}{1 \text{ ton CO}_2} = \$5 \text{ CO}_2 \text{ offset}$$

“Normalized” \$ units



Sustainability in AF Remediation: **Solution Method**

Sustainability Scenarios

“When you *spin scenarios*, you end up with an array of plausible futures – usually three to five possible stories of how the future will unfold for you, your organization, your community, or whatever you are focusing on.

The idea is *not* to decide *which of these tales is right*. Rather, the idea is to create an array of plausible futures.

The point of scenario-spinning is to help us “*suspend our disbelief*” in all possible futures, so that we can see the possibilities with clear eyes.” (Flower, 1997)

**Shell Oil
Scenarios:**

**“Scramble”
vs.
“Blueprint”**



Sustainability in AF Remediation: **Solution Method**

Sustainability Scenarios

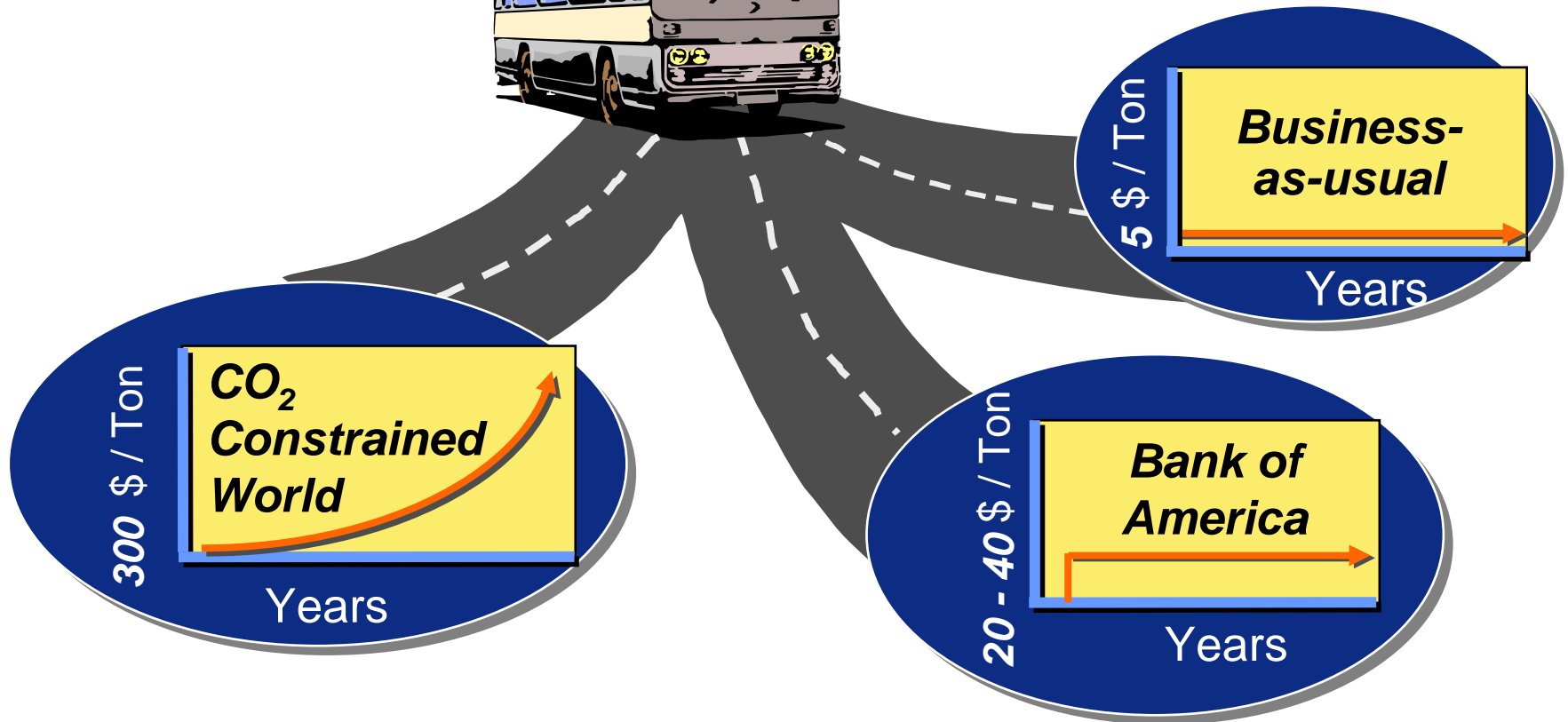
“The **Scramble** scenario is...where **self-interest predominates initially**. Voters in the West and in the developing world are unwilling to make radical changes in lifestyle. Politicians concentrate on trying to optimise within their own national perspectives. As a result there is **global competition for resources** and **little attention** paid to **cutting energy consumption**. Naturally, this will lead to new international political tensions and **greenhouse gas emissions** continue to **climb**.”

The **Blueprints** scenario is...more benign. Governments accept that climate change and skyrocketing global energy demand require a **co-ordinated solution** on the **Kyoto model**. This starts slowly – think the recent Bali accords – but gathers momentum in time to avoid the worst prospects for global warming and energy wars. **New energy technology** also plays a big role.”

(From <http://www.strategykinetics.com/2008/01/another-view-of.html>)



Three Carbon Emission Scenarios





Sustainability in AF Remediation: **Solution Method**

Energy Consumed Metric Example

$$32 \text{ gal gas} \times \frac{150 \text{ MJ}}{1 \text{ gal gas}} = 4,800 \text{ MJ energy}$$

“Non-normalized” natural units

$$32 \text{ gal gas} \times \frac{\$3.00}{1 \text{ gal gas}} = \$96$$

“Normalized” \$ units

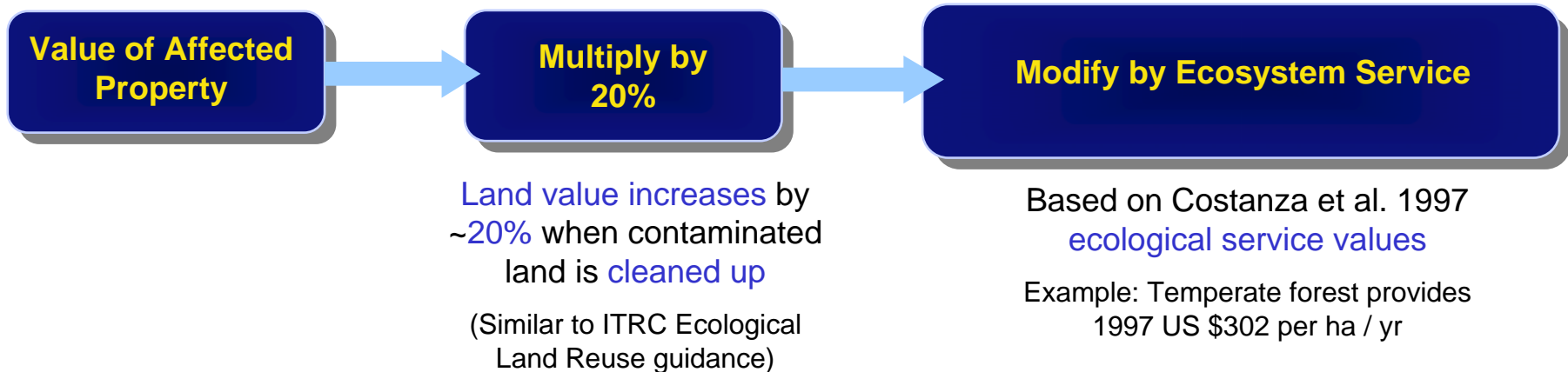


Sustainability in AF Remediation: **Solution Method**

Resource Service Land Valuation

“Non-normalized” metric reported as Land Use Before & After.

“Normalized” metric calculated as dollars.

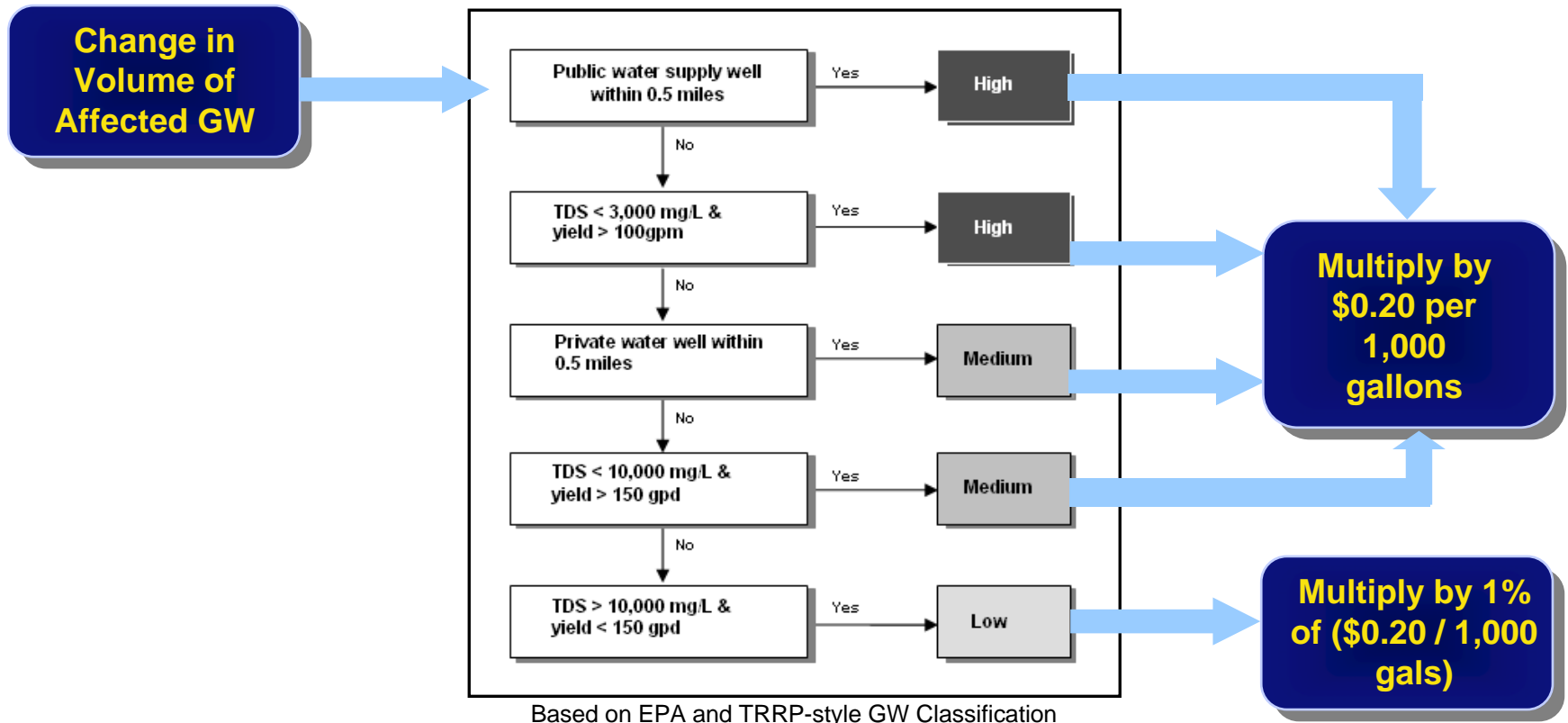




Sustainability in AF Remediation: Solution Method

“Non-normalized” Resource Service metric is based on volume of plume that is cleaned up

“Normalized” Resource Service Groundwater Valuation:





Sustainability in AF Remediation: **Solution Method**

Technology Cost Example

“Non-normalized” and “Normalized” units are the same

$$10,000 \text{ yd}^3 \times \frac{\$400}{1 \text{ yd}^3 \text{ Excavation}} = \$4,000,000$$

“Non-normalized” natural units

$$10,000 \text{ yd}^3 \times \frac{\$400}{1 \text{ yd}^3 \text{ Excavation}} = \$4,000,000$$

“Normalized” \$ units

Unit costs from Federal Roundtable



Sustainability in AF Remediation: ***Solution Method***

Safety / Accident Risk Example

$$\begin{aligned} & (1,000 \text{ hrs worked} + 400 \text{ hrs traveled}) \times \frac{2.7 \times 10^{-9} \text{ injuries}}{1 \text{ hr worked}} \\ & + (100 \text{ miles traveled}) \times \frac{91 \text{ injuries}}{100,000,000 \text{ VMT}} \\ & = 9.5 \times 10^{-5} \text{ injuries} \end{aligned}$$

“Non-normalized” natural units

$$\begin{aligned} & \frac{40 \text{ lost hrs}}{1 \text{ injury}} \times (9.5 \times 10^{-5} \text{ injuries}) \times \frac{\$80}{1 \text{ lost hr}} = \$0.30 \end{aligned}$$

“Normalized” natural units

Risk of non-fatal injuries derived from the US Bureau of Labor, 2006



Sustainability in AF Remediation: Solution Method

Soil/Source Results

Instructions:

- =Enter your data here. Click button to the right of the cell for help.
- =Use this default value or override with your own.
- =Calculated value. You cannot change this.

Recommended flow:



You are here*

* Go to Round Table to weigh results, go back to Inputs to adjust & compare, go back to Main (Tier 1/2 or GW), or Exit.

Non-normalized

Calculations in natural units

Excavation

SVE

Normalized/Cost-based

Results converted to dollars

Excavation

SVE

Carbon Dioxide Emissions to Atmosphere	<input type="text" value="21."/>	<input type="text" value="1,200."/>	tons CO ₂
CO2 per pound of contaminant	<input type="text" value="0.084"/>	<input type="text" value="4.8"/>	tons CO2 per lb contam
Total Energy Consumed	<input type="text" value="270,000."/>	<input type="text" value="390,000."/>	Megajoules
Technology Cost (minus energy)	<input type="text" value="\$430,000."/>	<input type="text" value="\$580,000."/>	dollars
Cost per pound of contaminant	<input type="text" value="\$1,700."/>	<input type="text" value="\$2,300."/>	dollars per lb contam
Safety/Accident Risk	<input type="text" value="0.44"/>	<input type="text" value="0.021"/>	lost hours
Change in Resource Service for Land - Economic	<input type="text" value="Net Gain"/>	<input type="text" value="Net Gain"/>	
Change in Resource Service for Land - Ecologic	<input type="text" value="Net Gain"/>	<input type="text" value="Net Gain"/>	

<input type="text" value="\$130."/>	<input type="text" value="\$7,200."/>	dollars
<input type="text" value="\$4,800."/>	<input type="text" value="\$230,000."/>	
<input type="text" value="\$430,000."/>	<input type="text" value="\$580,000."/>	
<input type="text" value="\$40."/>	<input type="text" value="\$10."/>	
<input type="text" value="-110."/>	<input type="text" value="-110."/>	
<input type="text" value="-53."/>	<input type="text" value="-53."/>	
<input type="text" value="\$430,000."/>	<input type="text" value="\$820,000."/>	\$

Scenarios

Scenarios

CALCULATION NOTE:

Gains are subtracted from the total.

"Gains reduce the total cost."

Round Table



Sustainability in AF Remediation: Solution Method

Soil/Source Round Table - Weigh the Results



Instructions:

- =Enter your data here. Click button to the right of the cell for help.
- =Use this default value or override with your own.
- =Calculated value. You cannot change this.

Instructions: Enter weights for each person (Total = 100%).

Adjust for % preferences

	Person 1	Person 2	Person 3	Person 4	Person 5
Carbon Dioxide Emissions to Atmosphere	50%	10%	30%	10%	5%
Total Energy Consumed	20%	50%	30%	10%	5%
Technology Cost	10%	20%	30%	10%	5%
Safety/Accident Risk	10%	10%	5%	40%	5%
Change in Resource Service for Land	100%	100%	100%	100%	100%

Excavation

Normalized/Cost-based Starting Point

Carbon Dioxide Emissions to Atmosphere	\$130	dollars
Total Energy Consumed	\$4,800	
Technology Cost	\$430,000	
Safety/Accident Risk	\$40	
Change in Resource Service for Land	-\$163	

\$430,000

\$635	dollars	\$63	dollars	\$129	dollars	\$129	dollars	\$129	dollars
\$9,379		\$11,674		\$4,746		\$4,749		\$4,774	
\$420,106		\$418,322		\$425,146		\$425,448		\$427,651	
\$39		\$19		\$7		\$158		\$40	
-\$159		-\$79		-\$27		-\$484		-\$2,594	

Consensus (Average) Results

\$217	dollars
\$7,064	
\$423,335	
\$53	
-\$669	

\$430,000

Differences, if any, due to rounding

Soil Vapor Extraction

Normalized/Cost-based Starting Point

Carbon Dioxide Emissions to Atmosphere	\$7,200	dollars
Total Energy Consumed	\$230,000	
Technology Cost	\$580,000	
Safety/Accident Risk	\$10	
Change in Resource Service for Land	-\$163	

\$820,000

\$27,439	dollars	\$2,548	dollars	\$7,225	dollars	\$7,229	dollars	\$7,248	dollars
\$350,607		\$406,984		\$230,795		\$230,915		\$231,524	
\$442,070		\$410,523		\$582,005		\$582,307		\$583,843	
\$8		\$4		\$2		\$40		\$10	
-\$124		-\$58		-\$27		-\$491		-\$2,625	

Consensus (Average) Results

\$10,338	dollars
\$290,165	
\$520,150	
\$13	
-\$665	

\$820,000

Differences, if any, due to rounding



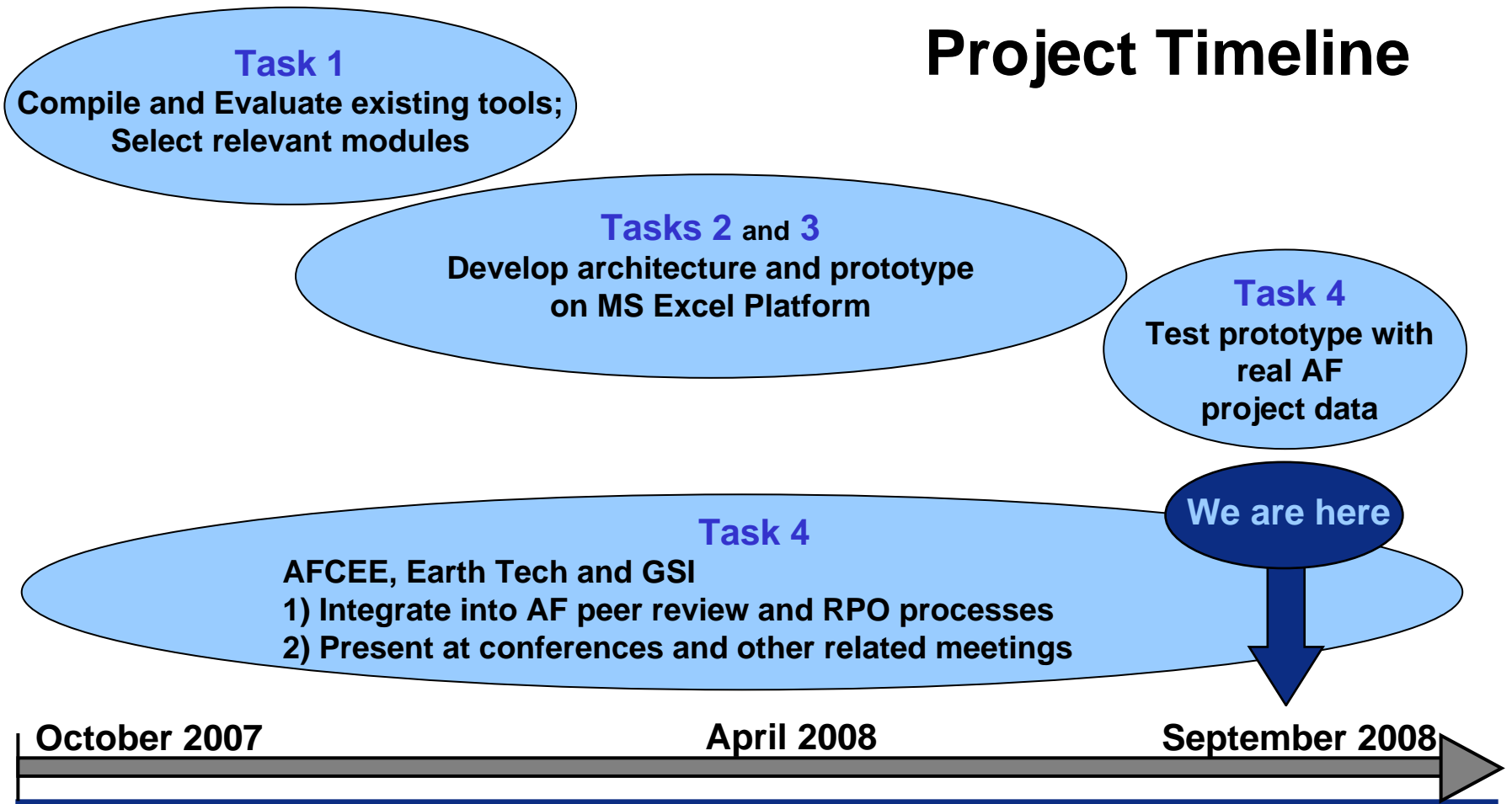
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Sustainability in AF Remediation: **Timeline**

Project Timeline





Questions / Discussion

